



CRITICAL REVIEW OF KAKAMACHI (*Solanum nigrum* Linn.)

*Dr. Varsha Babu¹, Dr. MS Deepa²

¹PG Scholar, Dept. of Dravyaguna vijnana, Govt. Ayurveda College, Thiruvananthapuram, Kerala, India. (*Corresponding Author)

²Professor, Dept. of Dravyaguna vijnana, Govt. Ayurveda College, Kerala, India.

ABSTRACT

Aim: To collect and comprehensively review information regarding the identification, pharmacological actions of Kakamachi (*Solanum nigrum* Linn.) The drug Kakamachi commonly known as black night shade found throughout India and has a long history of therapeutic tradition. It has been extensively used in traditional treatment for various ailments such as pain, inflammation and fever. A lot of research has also been conducted on this plant exploring its pharmacological action, but no review has comprehensively covered all aspects of *Kakamachi*. **Materials and methods:** The available literature on *Kakamachi* from original Ayurvedic scriptures, classical Ayurvedic texts from different periods, Indian Ayurvedic Pharmacopoeia, and scientific databases such as Science Direct, PubMed, and Google Scholar, with *kakamachi* and *Solanum nigrum* as keywords. **Conclusion:** In this research work, it was found that *Kakamachi* can be used for its nutritive value and medicinally for preventing various metabolic disorders and skin ailments.

KEYWORDS: *Kakamachi*, *Solanum nigrum* L., *Black night shades*.

INTRODUCTION:

The Kakmachi (*Solanum nigrum* Linn.), commonly called as black night shades, belongs to the family Solanaceae, are a global weed of arable land, gardens, river banks etc.,. However, they are frequently utilized as leafy vegetables, herbs, fruits, and for a variety of medicinal purposes.. Therefore, human consumption of their leaves and fruits as food is widespread, particularly in Africa, SE Asia and in some parts of India. It is commonly known as Makoy in North India, Manathakkali in Tamilnadu and Karinthakkali in Kerala *S. nigrum* has been extensively used in traditional treatment for various ailments such as pain, inflammation and fever. In folk medicine, berries are used as a tonic, laxative, appetite stimulant, and for the treatment of asthma, stomach ulcers, etc. . The seeds are laxative, useful in giddiness, gonorrhoea, etc. The juice from its roots is used against asthma and whooping cough. [1]

The word Kakamachi means the plant which is dear to crows. [2] Descriptions regarding Kakamachi can be found in brihatrayees and in most of the nighantus. It is described as *shaka dravya*(vegetable drug) as well as *oushdha dravya* (medicinal plant) in samhitas. Acharya Charaka widely used Kakamachi as *shaka dravya* in *sushkarsas* (haemorrhoids) and *vatika kasa*(dry cough). As an Oushadhi Dravya, he has explained Kakamachi in *Aragwadhadhi Lepa* for *Kushtha* (Skin diseases). [3, 4, 5] It is one of the ingredients in a *Shothahara lepa*, in *Visarpa* and in *Mahanila Taila*. [6, 7, 8] Acharya Sushruta mentioned the drug in *Shaka Varga* and explained it in *Suarasadi Gana*. Gadanigraha a book written in 12th century mentioned a separate chapter in *Rasayanadrikara* on Kakamachi. [9] Kakamachi is extensively used in Rasa preparations, either as a component in *Bhavana Dravya* or as an ingredient in the formulation. [10]

MATERIALS AND METHODS:

Scientific articles and publications on *S. nigrum* were gathered and sourced from various journals, then filtered using relevant keywords. The most influential articles and recent breakthroughs published on the contexts of phytochemistry, pharmacology were found using scientific databases such as PubMed, NCBI, Research Gate, Science Direct, etc. References regarding Kakamachi were compiled from various classical Ayurvedic texts.

REVIEW RESULTS:

Plant descriptions

Solanum is one of the world's largest and most complex genera, with over 1500 species, many of which are commercially important throughout their worldwide distribution. [11]

Synonyms:

Dhvakshamachi, Vayasahva, Vayasi, Sarvatikta, Bahuphala, Rasayani, Guchaphala, Kamata, kakanasa. [12]

Vernacular names:

Bengal - Gurkamai, Kakmachi, Mako, Tulidun

Bombay - Ghati, Kamuni, Mako

Hindi - Gurkamani, kabaiya, Makoi

Telugu - Gajuchettu, Kachi, Kakamachi, Kamanchi, Kanchipundu [13]

Properties and action

Rasa (Taste) - *Tikta*(Bitter), *Katu* (acid)

Guna (property) - *Laghu*(light), *snigdha*(Unctuous), *sara*(flowing)

Veerya (potency) – *Ushna*

Vipaka (Biotransformation of drug) - *Katu*

Karma (actions) – *Tridosahara* (alleviates all the three doshas) [14]

Action and Therapeutic indication [15 - 19]

Table 1: Action and Therapeutic indication

	Samanya karma	Therapeutic indication
DN	Rasyana, Vrshya, swarya	Kushta
MPN	Rasyana, Swara- sukrada, hrdhya	Sopha, kushta, arsas, jwara, meha,
RN	Rasyana, Vrshya, swarya	Sopha, kushta, arsas, Soola, Kandu
KN	Rasyana, Vrshya, swarya, Hrdhya, netrya	Sopha, kushta, arsas, jwara, meha, chardi, hrdroga, aruchi
BPN	Rasyana, Vrshya, swarya, netrya	Sopha, kushta, arsas, jwara, meha, chardi, hrdroga
PN	Balya, mutrala, Yaktritha	Sopha
API	Rasyana, Vrshya, swarya, hrdhya, bhedana	Sopha, kushta, kandu, arsas, jwara, meha, hikka, chardi, hrdroga, aruchi, netraroga

DN- Danwanthari Nighantu, MPN - Madhanapala Nighantu; RN- Raja Nighantu; KN- Kaiyyadeva Nighantu; BPN- Bhavaprakasha Nighantu; PN- Priya Nighantu; API – Ayurveda Pharmacopoeia of India

Taxonomy [20]

Kingdom - Plantae – Plants
Division - Magnoliophyta - Flowering plants
Class - Magnoliopsida – Dicotyledons
Order - Solanales
Family - Solanaceae - Potato family
Genus - *Solanum* L. - nightshade
Species - *Solanum nigrum* L. - black nightshade

Distribution:

They occur in throughout the temperate zones and in subtropical and tropical countries from sea level to 3000 m.

Description:

Solanum nigrum is a very mutable transient, annual or sometimes biennial herb, 0.2–1.0 m tall, reproducing by seed.

Root system- It has a strong white taproot, with many lateral roots being produced in moist and fertile surface soils.

Stems vary from prostrate to ascending or erect, and from herbaceous in ephemeral plants to rather woody or even shrubby in those that survive long enough to be biennial. Stems are round or angular, smooth or sparsely hairy, and green to purplish.

Leaves are alternate, ovate and are carried on short stalks, 2–8 cm long, and vary between plants from smooth-edged to shallowly lobed. They are opaque, dark green both above and below, and either smooth or finely hairy.

Flowers- small, white, star-shaped flowers in umbels on slender stalks developing directly from the stems between the leaves. Each cluster usually carries from 5–10 flowers, which open sequentially over several days. The flowers are 5-8 mm diameter, and have prominent yellow centres.

Fruits are globular, dark green, berries 5–13 mm across, matt black when ripe, which contain many flattened, finely pitted, yellow to dark brown woody seeds approximately 1.5 mm long. [20]



Figure 1: Morphology of Kakamachi (*Solanum nigrum* Linn.)

Official part: Whole plant [19]

Chemical constituents [21] :

It contains many steroidal glycosides, steroidal alkaloids, steroidal oligoglycosides, including solamargine, solasonine, solavilline, solasdamine, and solanine, flavonoids, steroidal saponins and glycoprotein, many polyphenolic compounds such as gallic acid, protocatechuic acid, catechin, caffeic acid, epicatechin, rutin, and naringenin, which possess strong antioxidant and anticancer activity. Besides these some proteins, carbohydrates, m coumarins and phytosterols, crude polysaccharides, polyphenols, gentisic acid, luteolin, apigenin, kaempferol, anthocyanidin have also been reported

Nutritive value of *Solanum nigrum* Linn Leaves [21]

Table 2: Nutritive values of Kakamachi

Moisture	82.1g
Protein	5.9g
Fat	1.0g
Minerals	2.1g
Carbohydrates	8.9g
Calcium	410mg
Phosphorous	70 mg
Iron	20.5mg
Riboflavin	.59mg
Nicotinic acid	.92mg
Beta- carotene	.74mg
Vit C	11mg

Research activities:

Anti-Cancer activity [22-23]

The aqueous extract of the *Solanum nigrum* Linn leaves, demonstrated significant cytotoxicity in human breast cancer cells via suppression of EMT and apoptosis. Furthermore, it was also capable of enhancing mitochondrial fission, thereby attenuating mitochondrial function in the human breast cancer cell line (MCF-7 cells). In this study, AESN attenuate N-cadherin, vimentin, and ZEB1 levels of MCF-7 breast cancer cells after 24 h treatment, revealing that AESN may demonstrate chemotherapy resistance, metastasis, and cancer cell migration as well as suppress cancer cell proliferation. These in vitro results suggested that the use of AESN could be potentially beneficial in treating breast cancer cells, and may be of interest for further studies in developing integrative cancer therapy against proliferation, metastasis, and migration of breast cancer cells. Utroside B, a potent saponin has been isolated and characterized from the leaves of *Solanum nigrum* Linn. It comprises of β -D-glucopyranosyl unit at C-26 of the furostanol and β -lycotetraosyl unit at C-3, is ten times more cytotoxic to the liver cancer cell line, HepG2 (IC₅₀: 0.5 μ M) than sorafenib (IC₅₀: 5.8 μ M), the only FDA-approved drug for liver cancer. Moreover, it induces cytotoxicity in all liver cancer cell lines, irrespective of their HBV status, while being non-toxic to normal immortalized hepatocytes. It induces apoptosis in HepG2 cells by down-regulating mainly the activation of MAPK and mTOR pathways. The drastic reduction in HepG2-xenograft tumor size achieved by utroside B in NOD-SCID mice and substantiation of its biological safety through both acute and chronic toxicity studies in Swiss albino mice warrants clinical validation of the molecule against hepatic cancer, for which, the chemotherapeutic armamentarium currently has limited weapons.

Antioxidant activity [24]

Agata campisi et al concluded that, the two leave extracts of *Solanum nigrum* L. (methanolic/ water (80:20) (SN1) and water (SN2) leaves extracts were able to restore the oxidative status, modified by glutamate in primary cultures of astrocytes, the study evaluated the glutathione levels, the intracellular oxidative stress, and the cytotoxicity. Extracts were able to quench the free radical in an *in vitro* free cellular system and restore the oxidative status in *in vitro* primary cultures of rat astroglial cells exposed to glutamate. These extracts prevented the increase in glutamate uptake and inhibited glutamate excitotoxicity, which leads to cell damage and shows a notable antioxidant property. Antioxidant activity might be due to the presence of polyphenolic compounds.

Immuno modulatory activity [25]

The immunomodulatory activity assay in vitro showed that SNLP-1 promoted the release of NO and TNF- α and IL-6 secretion in macrophages. In tumor-bearing mice, SNLP-1 could improve immune function including increasing the spleen index, thymus index and inducing Th1 responses mediated by IL-2, IFN- γ , and TNF, as well as decreasing the tumor weight. Furthermore, SNLP-1 elevated the expression of the critical nodes in the TLR4-Myd88 signaling pathways in vitro and in vivo. These results indicated that TLR4-Myd88 signal pathway may be one of the signal pathways of immune regulation of SNLP-1.

Anti-diabetic activity [26]

Aqueous extract of *Solanum nigrum* Linn berries in the dose of 200 mg/kg/day produced significant reduction in blood glucose from day 7 and 400 mg/kg/day produced highly significant reduction in blood glucose from day 7. Histopathological features show the regeneration of islets of Langerhans.

Anti-hyperlipidaemic activity [27]

The possible protective effect of *Solanum nigrum* fruit extract (SNFet) was investigated for its antioxidant and antihyperlipidemic activity against ethanol-induced toxicity in rats. In the lipid profiles, the levels of total cholesterol (TC), triglycerides (TG), low density lipoproteins (LDL), very low density lipoproteins (VLDL), free fatty acids (FFA), and phospholipids were significantly elevated in the ethanol-induced group, whereas, the high density lipoproteins (HDL) were found to be reduced in the plasma, and the phospholipid levels were significantly decreased in the tissues. Supplementation of SNFet improved the antioxidant status by decreasing the levels of TBARS and altering the lipid profiles to near normal.

Cardioprotective activity [28]

The methanolic extract of *S. nigrum* berries had shown cardio protective and antioxidant effect. All cardiac serum marker levels (creatinine phosphokinase MB, lactate dehydrogenase, serum glutamate oxaloacetate transaminase and serum glutamate pyruvate transaminase) were found significant reduction in rise of these parameters in a time dependent manner indicating cardio protection.

Anti-biofilm activity [29]

In the study conducted by Khaled, J. M. et al, the anti-biofilm effect of essential oils was recovered from the medicinal plant of *Solanum nigrum*, and confirmed the available essential oils by liquid chromatography-mass spectroscopy analysis. The excellent anti-microbial activity and minimum biofilm inhibition concentration of the essential oils against *P. mirabilis* was indicated at 200 μ g/mL. The absence of viability and altered exopolysaccharide structure of treated cells were showed by biofilm metabolic assay and phenol-sulphuric acid method. The fluorescence differentiation of *P. mirabilis* treated cells was showed with more damages by confocal laser scanning electron microscope. Further, more mor-

phological changes of essential oils treated cells were differentiated from normal cells by scanning electron microscope. Altogether, the results were reported that the *S. nigrum* essential oils have anti-biofilm ability.

Hepatoprotective activity [30]

The liver protecting property of SN was evaluated by means of various biochemical parameters and histopathologically. *S. nigrum* was administered to Swiss strain female albino mice with either 100/ 200/ 300 mg/kg body weight/day for 30 days along with CCl₄ which is a well established model to induce hepatotoxicity. Administration of CCl₄ for 30 days caused a significant increase in liver marker enzymes and a decrease in hepatic DNA, RNA and protein levels which was effectively mitigated by treatment with the plant extract in a dose dependent manner. Similarly co-treatment of the extract along with the hepatotoxin improved hepatic energy status by increasing the activities of succinate dehydrogenase (SDH) and adenosine triphosphatase (ATPase). Histopathological findings indicated severe vacuolization and necrotic changes after CCl₄ treatment which was mitigated by the co-administration of SN extract in a dose-dependent manner.

Anti-convulsant activity [31]

Wannang, N, et al reported the aqueous leave extract of *S. nigrum* was found to offer protection against electrically, pentylenetetrazole and picrotoxin-induced seizures. This anticonvulsant property was potentiated by amphetamine, thus, the activity may probably be via the dopaminergic pathway. This result has provided the rationale of the use of this plant in the treatment of seizures.

Neuropharmacological activity [32]

Perez, R. et al reported, ethanol extract of the fruit of *Solanum nigrum* L. was studied for its neuro-pharmacological properties on experimental animals. On intra peritoneal injection, the extract significantly prolonged pentobarbital-induced sleeping time, produced alteration in the general behaviour pattern, reduced exploratory behaviour pattern, suppressed the aggressive behaviour, affected loco motor activity and reduced spontaneous motility.

DISCUSSION:

Kakamachi commonly known as black night shade found throughout the world, has a long history of therapeutic tradition. It is described in *brihattrayeeyas* and in most of the *nighantus*. While doing literature review, synonyms like *vayasi* and *kakanasika* were mentioned for two other drugs namely *Kakanasa* (*Pentatropis microphylla*) and *kakajangha* (*Peristrophe bicalculata*). Kakamachi is a *sakha dravya*. But *Kakanasa* and *kakajangha* are not *sakha dravya*. So there is no controversy regarding the identification of Kakamachi. It contains many steroidal glycosides, steroidal alkaloids, steroidal oligoglycosides, polysaccharides etc. The steroidal alkaloids and glycoproteins are exhibiting anti-tumor activity. The ant-diabetic activity might probably be due to the presence of bioactive principles like flavonoids, Saponin and the antioxidant and anti-inflammatory properties of berries of *Solanum nigrum*. Ayurveda described Kakamachi as *katu tikta* in *rasa*, *laghu*, *sara guna*, *ushna veerya*, *katu vipaka*, *tridoshagni* (pacifies *tridoshas*), *rasayana* (rejuvenative), *hrdrgavinasana* (beneficial in curing heart disease) *mehajith* (anti-diabetic), *sophaghna* (anti-inflammatory) and *yakrtuttejaka* (hepatoprotective). Its hypoglycemic, dyslipidemic, hepatoprotective, Anti-ulcer activity, Cardioprotective activity, Cardioprotective activity effects were proven experimentally. Also Kakamachi is a good source of magnesium phosphorus and the water soluble vitamins such as vit C, B and folic acid.

CONCLUSION:

Ayurveda promotes the use of Kakamachi by including it in both *Sakha varga* (vegetable) and *oushadha varga* (medicinal). It is said to be as a rejuvenative, hepato-protective, cardio-protective, anti-diabetic, beneficial in skin ailments, etc. in various classic textbooks. While going through the recent research studies of the plant, it can be said without doubt that the aerial parts of Kakamachi can be utilized for preventing various metabolic disorders and skin ailments. Its anti-oxidant, anti-inflammatory, hypoglycemic, dyslipidemic and hepato-protective activities can be attributed to its chemical constituent's flavonoids, Saponin, glycosides, polyphenol compounds and minerals.

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